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PATENT SPECIFICATION

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(54) PRODUCTION OF IMPROVED LUBRICATING OILS

(71) We, TEXACO DEVELOPMENT CORPORATION, a Corporation organized and existing under the laws of the State of Delaware, United States of America, of 135 East 42nd Street, New York, New York 10017, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the production of improved lubricating oils. More particularly, it is concerned with a process sequence for the production of lubricating oils of high viscosity index. In one of its more specific aspects, it is concerned with the production of high viscosity index lubricating oils from low grade lubricating oil charge stocks using a process sequence which includes hydrorefining without resort to severe hydrorefining conditions.

Various steps for the refining of lubricating oils such as distillation, solvent refining, solvent dewaxing, acid treating and clay contacting are well known. When residual type oils are being processed, a preliminary step of deasphalting is also generally required.

In the processing steps listed above distillation is employed as a means of separating a crude oil into fractions of various viscosities, solvent refining with, for example, furfural, sulfur dioxide, phenol or N - methyl-2 - pyrrolidone is ordinarily used as a means of removing aromatic compounds and thereby improving the viscosity index, solvent dewaxing using for example a mixture of methyl ethyl ketone and toluene is used to lower the pour point of the oil, acid treating is used to improve the color stability and resistance of the lubricating oil to oxidation, and clay contacting is used generally as a final step to further improve the color and to neutralize the oil after acid treating.

Catalytic hydrogenation of lubricating oil is a method of refining lubricating oils with hydrogen in the presence of a catalyst and

has the advantage over solvent refining to improve the viscosity index, and over clay treating to improve the color in that the yields of treated oils are much higher for the hydrogenation process than for solvent refining and clay treating. Further, oils of higher viscosity index can be produced by the hydrogenation process than is practical by solvent refining. It has therefore become advantageous in the lubricating oil refining art to use hydrorefining as a substitute for solvent refining and clay treating and to complete the refining process by solvent dewaxing. Unfortunately, subjecting a lubricating oil to a dewaxing treatment to reduce the pour point also results in an undesirable reduction of the viscosity index. In a processing sequence involving hydrorefining, it has therefore become necessary, in order to obtain a high viscosity index dewaxed product, to carry out the hydrorefining under extremely severe conditions to produce a lube oil of sufficiently high viscosity index that after dewaxing a product oil is obtained having the desired viscosity index. This severe hydrorefining is undesirable not only in that it requires severe conditions such as high temperatures and low space velocities but also in that it results in a low product yield. Lowering the space velocity of the oil through the catalytic reactor means a reduced capacity in terms of throughput, and to compensate by constructing a larger reactor represents a large increase in investment costs both as to the equipment and catalyst.

The present invention provides a novel combination of steps for producing a lubricating oil having an improved viscosity index. It is possible to produce an improved lubricating oil using moderate hydrorefining conditions, an improved dewaxed lubricating oil in good yield having a superior viscosity index at the same viscosity level as severely hydro-refined oil, and a lubricating oil of good color and color stability.

According to the process of our invention,

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2 catalysts for use in comprise metals Group VI and Table. Examples chromium, molybdenum, and nickel and these components comprising a refractory such as alumina, silica, and mixtures used in the form or a fixed bed. a fixed bed, the or downwardly may be counterparticularly suitable g from 3—10% 15% molybdenum 70 are those containing 20% tungsten cobalt and 15% alumina. Although chemical change the presence of the catalyst is oxide or sulfide with the charge. It is subjected to 80 part of our invention the hydrorefining out intermediate 95 a catalyst component, such as the catalyst, supermordenite. Preferably treating a syn- 100 to replace the ion. Advantageously is treated with portion of the 105 mordenite 110 and increased 115 de waxing may 120 ture of at least 100 psig, and 125 Naturally when reduced directly 130 one, the hydro- 135 de waxing zone, sub- 140 in the hydro- 145 de waxing zone as the hydro- 150 de waxing zone. Preferred 155 de waxing zone are 160 a pressure of 165 velocity of 0.20— 170 and light hydro- 175 de waxing zone 180 the hydro- 185 oil then con- 190 such as a mix- 195 ture or methyl 200 diene or a mix- 205 ture of a mix- 210 ture of a mix- 215 ture cooled 220

3 to a temperature of about 0 to —20°F. and the waxy components removed by filtering or centrifuging. The filtrate is then subjected to flash distillation and stripping to remove the solvent.

5 By interposing a solvent refining step between the distillation or deasphalting step and the hydrorefining step it is now possible to obtain a dewaxed product at a specified viscosity index for a particular viscosity using milder hydrorefining conditions, particularly the space velocity, than was possible using the processes of the prior art. Operating the hydrorefiner at increased throughput is advantageous in that a smaller unit need be built for a particular capacity or in cases where the unit is already built, the capacity is

greatly increased, in some instances as much as 400%.

10 The invention will now be illustrated by the following examples, in which Examples 1 and 3 are given for comparative purposes. In these Examples, "Flash °F. (PM)" refers to the Pensky-Martens test (ASTM D93—62) and "Flash COC, °F." refers to the Cleveland Open Cup test (ASTM D92—57).

EXAMPLE I

15 In this example the charge is a deasphalted residuum having the characteristics set forth in column A of Table 1 below. For comparison purposes, the characteristics of the dewaxed charge are listed in column B.

TABLE 1

	A	B
Gravity, °API	25.5	23.5
Flash, °F.	560 (COC)	500+ (PM)
Viscosity, SUS/210°F.	121.8	139.6
Viscosity Index	87	79
Pour, °F.	+110	-5

100 Hydrorefining conditions over a catalyst 35 composed of 5.9% Ni and 18.3% W supported on an alumina base and characteristics 105 of the MEK:toluene dewaxed hydrorefined 110 product are tabulated below.

TABLE 2

Process Conditions

Run No.	1	2
Reactor Temp. °F.	800	775
Pressure, psig.	2500	2500
Space Velocity, v/v/hr	0.49	0.21
Hydrogen rate, SCFB	4520	6300
Product (Dewaxed)		
Gravity, °API	30.9	31.4
Flash, °F. (PM)	375	380
Viscosity, SUS/210°F.	50.5	50.6
Viscosity Index	117	118
Pour, °F.	+10	-5
Overall Yield, vol. %	63	61

EXAMPLE II

In this example, the same charge stock used in Example I is subjected to a preliminary solvent extraction using furfural as the solvent and the so-treated oil is then

hydrorefined and dewaxed. Operating data of the process and characteristics of the charge and product appear below. Data on the dewaxed charge are included for comparison purposes.

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TABLE 3

Tesis	Charge	Dewaxed Charge
Gravity, °API	28.6	27.6
Flash, °F.	570 (COC)	425 (PM)
Viscosity, SUS/210°F.	102.3	112.3
Viscosity Index	105	95
Pour, °F.	+120	0

Process Conditions	3	4
Run No.		
Reactor Temp., °F.	800	773
Pressure, psig.	2500	2500
Space velocity, v/v/hr.	0.47	0.26
Hydrogen rate, SCFB	4700	5100

Product (Dewaxed)	3	4
Run No.		
Gravity, °API	33.3	32.9
Flash, °F. (PM)	385	385
Viscosity, SUS/210°F.	49.5	50.4
Viscosity Index	128	124
Pour, °F.	+5	+5

Lube oil yield from Run 3 hydrorefining step is 71.5 volume per cent and from Run 4 hydrorefining step is 72 volume per cent.

EXAMPLE III

15 In this example, the charge is a wax dis-

tillate having the characteristics set forth in Column A of Table 4. For comparison purposes, the characteristics of the dewaxed charge are listed in Column B.

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Hydrorefining conditions over a catalyst composed of 5.9% Nickel and 18.3% tungsten supported on an alumina base and the characteristics of the MEK:toluene dewaxed hydrorefined product are tabulated below. 5

TABLE 4

	A	B
Gravity, °API	22.4	21.3
Flash, COC, °F.	420	—
Viscosity, SUS/210°F.	57.9	62.0
Viscosity Index	70	56
Pour, °F.	+100	0

TABLE 5

Process Conditions	Run 5
Temperature, °F.	775
Pressure, psig.	1500
Space Velocity, v/v/hr.	0.25
H ₂ rate, SCFB	5000
Product (Dewaxed)	
Gravity, °API	29.6
Flash, COC, °F.	400
Viscosity, SUS/210°F.	43.7
Viscosity Index	100
Pour, °F.	-5
Overall Yield, vol. %	51

EXAMPLE IV

In this example the same charge as used in Example III is subjected to preliminary solvent refining using furfural as the solvent and then is mildly hydrorefined and dewaxed. 10

Characteristics of the charge, product and reaction conditions are tabulated below. Data on the dewaxed charge are included for comparison purposes.

TABLE 6

Charge	As Used-	Dewaxed
Gravity, °API	30.0	28.4
Flash, COC, °F.	370	—
Viscosity, SUS/210°F.	50.7	54.0
Viscosity Index	107	89
Pour, °F.	+105	0

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comparison pur-
dewaxed charge

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Hydrorefining conditions over a catalyst composed of 5.9% nickel and 18.3% tungsten supported on an alumina base and the characteristics of the MEK:toluene dewaxed hydrorefined product are tabulated below.

TABLE 7

Run No.	6	7
Process Conditions		
Temperature, °F.	775	775
Pressure, psig.	1500	1500
Space Velocity, v/v/hr.	1.0	0.5
H ₂ rate, SCFB	5000	5000
Product (Dewaxed)		
Gravity, °API	30.5	31.8
Flash, COC, °F.	400	395
Viscosity, SUS/210°F.	46.2	43.1
Viscosity Index	101	110
Pour, °F.	0	-20
Overall Yield, vol. %	73	65

It will be observed from Table 5 that by conventional processing, a space velocity of 0.25 yielded a product having a viscosity index of 100 and viscosity SUS/210°F. of 43.7. Table 7 shows that by our process, a product oil of essentially the same viscosity index can be obtained at a space velocity of 1, a rate 4 times as fast as in Run 5 and also an oil having an improved viscosity index of 110 can be obtained at twice the flow rate of Run 5. Lube oil yield from Run 6

hydrorefining step is 86.5 volume per cent and from Run 7 hydrorefining step 77.7 volume per cent.

EXAMPLE V
This example shows the improved colour obtained by our process. In Table 8, vast improvement is shown in Runs 3 and 6 from above where the oil is furfural refined before hydrorefining over Runs 1 and 5 where the furfural refining step is omitted.

TABLE 8

Hydrorefining Run No.	1	3	5	6
Charge Color, Lovibond 1"	440	105	220	25
Product Color, Initial, Lovibond 6".	175	45	45 1/2"	50
Product Color after 24 hrs./200°F. Lovibond 6"	—	55	45 1/2"	55

WHAT WE CLAIM IS:—

1. A process for the production of a lubricating oil of improved viscosity index which comprises subjecting a lube oil charge stock

to solvent extraction to reduce the aromatic content thereof, passing the solvent refined material into contact with a hydrorefining catalyst under hydrorefining conditions and

- 6
dewaxed
5
below.
- 7
then subjecting the hydrorefined material to
dewaxing.
2. A process as claimed in claim 1, in
which the hydrorefined product is catalytic-
ally dewaxed.
- 5 3. A process as claimed in claim 2, in
which the hydrorefining zone effluent is passed
directly to the catalytic dewaxing zone.
- 10 4. A process as claimed in claim 1, 2 or
3, in which the dewaxing catalyst comprises
a hydrogenating component supported on de-
cationized mordenite.
- 15 5. A process as claimed in claim 1, in
which the hydrorefined material is solvent de-
waxed.
- 16 6. A process as claimed in any preceding
claim, in which the charge stock has a vis-
cosity index not greater than 90.
- 20 7. A process as claimed in any preceding
claim, in which the charge stock has a vis-
cosity index below 75 and the dewaxed pro-
duct has a viscosity index of at least 100.
8. A process as claimed in any preceding
claim, wherein the hydrorefining catalyst com-
- prises cobalt or nickel and molybdenum or 25
tungsten.
9. A process as claimed in any preceding
claim, wherein the hydrorefining conditions
comprise a temperature between 600 and
900°F., a pressure between 800 and 5000
psig, a hydrogen rate between 1500 and 20,000
SCFB and a space velocity between 0.1 and
5.0 volume of oil per volume of catalyst per
hour.
10. A process for the production of a 35
lubricating oil substantially as hereinbefore
described with reference to Examples 2, 4
or 5.
11. Lubricating oils whenever prepared or
produced by a process claimed in any of the 40
preceding claims.

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